

200 miles apart, so that good forecasts are not always officially verified. Again, when these local storms are forecast for a given State, some of the towns may have a storm and some may not, so that certain persons may criticise adversely a perfectly correct forecast. Again, a discrepancy between the general public and the Bureau arises as to the system of verifying forecasts in one particular, viz, as regards temperatures in summer. The public notes the maximum temperatures of the afternoon; the Bureau verifies by the 8 p.m. map, several hours later than the time of maximum temperature. Now, if, after a hot day, a thunderstorm comes up and lowers the evening temperature decidedly, there is this difficulty in making the forecast. In the natural recovery of the ordinary summer temperature, the forecast should be warmer; but as the temperature before the storm was, for example, 95°, it is hardly fair to the public to make the forecast "warmer" for the 8 p.m. hour, since a higher maximum temperature would not probably occur. There is little else to be done than to sacrifice the record of the forecaster in favor of the public comfort.

A peculiar case of unexpected thunderstorms occurred on July 19, when they suddenly spread from the Lake region to the middle Atlantic coast, directly across the isobars of a high area. A fall of temperature occurred generally in New England and the North Atlantic States, where one would have expected a decided rise, judging from the positions of the high and low areas. These anomalies, in addition to the stagnant condition of the eastward movements, sometimes render the forecast of the summer months unusually difficult.—*F. H. Bigelow, Professor.*

COOL WAVE FORECAST.

An interesting case of the development of unusual weather conditions occurred during July 6–10. On the 6th an area of high pressure was central over New England, with every prospect that it would move to the northeastward. But on the 7th it began to settle southward along the Atlantic coast, and gradually became central on the south Atlantic coast, causing meanwhile thunderstorms in the east Gulf States. These were forecast on the 6th and 7th. Then, on the 8th, occurred a sudden fall in the pressure generally over the Atlantic States, with no apparent reason for it, and a low area developed over New England; at the same time a high area formed in the Northwest. On the morning of the 8th the forecast was made "pleasant temperature will prevail for two or three days in the District of Columbia, New England, and the Middle Atlantic States." A large high area passed over the northern districts, and from the 9th to the 13th cool and fair weather prevailed generally in these districts. These meteorologically rare conditions are by no means easy to understand, and they probably depend upon the atmospheric currents of the higher strata.—*F. H. Bigelow, Professor.*

HIGH TEMPERATURE FORECASTS.

On July 1, 2, 3, and 4 a warm wave with very high temperatures passed from the South Atlantic States northward over New England. During this period an area of high pressure was stationary off the south Atlantic coast, and a low area moved from the lower Missouri Valley and the Lakes to New England; these are conditions favorable for producing hot weather in the Atlantic States. On Chart VIII will be found the isotherms of the maximum temperatures for the above dates, showing the location of the hot wave. The forecasts of June 29 and 30 foretold the formation of the hot wave by saying, "high temperatures are indicated for the central valleys, the Gulf and Atlantic States, and New England," June 30; "continued high temperature" in same districts, July 1; "very high temperature," "very warm," July

2; "very warm," July 3, a. m.; "the temperature will be lower Monday in New England and the Middle Atlantic States," July 3, p. m.; "cooler weather," "cool in New England and the Atlantic States," July 4.

By following the progress of the heated area toward the northeast, and comparing with the forecasts, it will be seen that the course of development was satisfactorily anticipated.

From July 22 to 29 high temperatures prevailed on the Rocky Mountain slope, and the air being dry this period was unfavorable to the crops of those districts. A sketch of the series of maximum temperatures, frequently above 100°, is found on Charts Nos. IX, X, XI, and XII. The following forecasts were made: July 21, 8 p. m., "the temperature will continue warm throughout the Rocky Mountain districts;" July 22, "very high temperature will prevail on the Rocky Mountain slope;" July 23, "the temperature will continue high in the Southwest States;" and similarly for the following dates till the hot wave was broken. During this period the temperatures were high also in the Atlantic States but moderate in the Lake region.—*F. H. Bigelow, Professor.*

FORECASTS AT CHICAGO, ILL.

No storm signals were ordered for the upper Lakes during the month and no winds of a violent character occurred, except in the form of local squalls, which were forecast in daily advisory telegrams sent to Lake ports.

The most important weather feature of the month in the agricultural districts of the West and Northwest was the very warm and dry period, which continued until the 19th. The hot winds, which marked the closing days of the heated spell, had become a serious menace to crops, and the break in temperature during the day and night of the 19th was attended by local rains and thunderstorms generally in the principal corn and wheat growing States.

The Chicago morning forecast of the 18th called for—

Local rains and thunderstorms in the northern tier of States from Michigan to Montana.

And the forecast of the 19th reads:

The indications are that showers will occur this afternoon and to-night in the States of the Missouri and upper Mississippi valleys and the western Lake region, with a more moderate temperature. On the upper Lakes fresh to brisk south to southwest winds, with local rains and thunder squalls, during the next twenty-four hours.

The anticipated thunderstorms were not severe, except over extreme southern Lake Michigan and in the neighborhood of Chicago, where a day of intense heat was followed, about 7 p. m., by a fall in temperature of 25° in twenty minutes and a rather severe squall of wind and rain. The morning local forecast for Chicago and vicinity was:

Conditions will be favorable for thunderstorms, squalls, and lower temperature to-night.

The forecasts were verified in detail.

Although high temperature prevailed in the corn and wheat growing districts during the remainder of the month, local rains, which were copious in localities, prevented a reestablishment of the drought conditions which were developed prior to the 19th.

An extraordinary fall of hail attended a thunderstorm at Chicago the evening of the 23th. Hail, varying in size from one-half to two inches in diameter and one-fourth to one-half inch in thickness, fell in a comparatively narrow belt which crossed the city from west-southwest to east-northeast, covering the business center and causing considerable damage, principally to window glass.—*E. B. Garriott, Professor and Forecast Official.*

FORECASTS AT SAN FRANCISCO, CAL.

No wind signals were ordered from this station during the month.

WARNINGS OF UNUSUAL WEATHER CONDITIONS.

The only injurious conditions that occurred during July, 1898, were "northers" on the 15th and 26th, both of which were satisfactorily forecast on the previous day, and information furnished to all interested. The "norther" of July 25 was followed by a period of extremely high temperature throughout the interior of the State.—*W. H. Hammon, Local Forecast Official.*

FORECASTS AT PORTLAND, OREG.

No wind-signal orders were issued during the month, as there were no storms.

The "summer type" of weather conditions did not appear until the 7th, and even then the type was indistinct and not perfect in its movement. The areas of low pressure continued central too long over southeastern Oregon, and the areas of high pressure, in their eastward course, moved too much to the southeast. The movement of the highs, from the 21st to the close of the month, approximated closer to the summer type than any former ones this year. The movement of the summer highs has a relation to the movement of the lows in winter. When this relation is clearly defined, seasonal forecasts are possible. Under the influence of the summer highs, forecasts for several days are made with accuracy. Such forecasts are appreciated and are of value to the people. July and August are dry months, and the forecasts for thirty-six hours are not as valuable as in the other ten months of the year. The general information issued concerning crops, the wheat service reports, etc., are deemed of greater value during the dry season than any other information issued, though the weather and temperature forecasts, when marked changes occur, are of direct value. The output of ice factories and the shipment of frozen salmon and perishable produce are guided to a very great extent by the forecasts during heated periods. During the month resorts at the Beach and the steamers on the Willamette and Columbia rivers requested information upon which to base their operations.—*B. S. Pague, Local Forecast Official.*

AREAS OF HIGH AND LOW PRESSURES.

The tracks of six highs and the same number of lows were sufficiently well defined to be mapped on Charts I and II. On these charts are given the approximate position of the center of high or low twice each day, and also the barometer reading at the point nearest that center. The accompanying table presents a few facts as to the region of origin and disappearance, the length of path, and the velocity of the high or low. The following is a general description:

Highs.—The principal point of interest in the highs of this month has been their origin off the Pacific coast. In the case of IV, V, and VI, they were first noted off the south Pacific coast, and first moved up the coast before appearing on the land and moving to the interior. Highs I and II may have had such a motion, but the observations are too close to land to show it. Such motion has been noted in several months previously, and seems rather significant, though observations will be needed at sea in order to show the complete trajectory and surrounding pressure conditions giving rise to such a motion. The general track of the highs was in rather high latitudes. Highs I, II, and IV were last seen off the north Atlantic coast, III and VI disappeared off the south Atlantic coast, and V in the upper Lake region.

Lows.—All the lows began to the north of Montana and moved mostly to the north of the United States. No. I disappeared in Iowa, and the rest in or near the Gulf of St. Lawrence. The thunderstorms of the month, as reported by telegraph, culminated as follows: 3d, 23; 8th, 28; 17th, 26;

19th, 27; 23d, 25; 25th, 29; 28th, 23; 29th, 26; and 30th, 24. These storms occurred either in the southeast quadrant of a low or between two highs, or in a disturbed region showing a combination of these conditions.

The highest winds of the month were as follows: As low II passed into the Gulf of St. Lawrence a squall of 44 miles an hour occurred at Atlantic City, p. m. of 4th. On a. m. of 13th a squall of 60 miles an hour occurred at Sandy Hook. The storm in this case was off the New Jersey coast. On p. m. of 19th Green Bay had a thunderstorm squall of wind reaching 48 miles, and on 20th, p. m., Cleveland reported a squall wind of 52 miles.—*H. A. Hazen, Professor.*

Movements of centers of areas of high and low pressure.

Number.	First observed.			Last observed.			Path.		Average velocities.	
	Date.	Lat. N.	Long. W.	Date.	Lat. N.	Long. W.	Length.	Duration.	Daily.	Hourly.
High areas.										
I.....	1, a. m.	47	136	6, p. m.	42	65	3,570	5.5	649	27.0
II.....	6, a. m.	48	128	13, p. m.	47	60	3,750	7.5	500	20.8
III.....	13, a. m.	43	81	17, p. m.	24	81	2,160	4.5	480	20.0
IV.....	16, a. m.	37	124	24, p. m.	41	68	4,980	8.5	562	23.4
V.....	21, p. m.	42	127	26, p. m.	45	39	2,400	4.5	535	22.2
VI.....	27, a. m.	50	134	72, p. m.	31	79	3,030	6.5	458	19.1
Total.....							12,740	37.0	3,182
Mean of 6 paths.....							3,290		530	22.1
Mean of 37 days.....									534	22.2
Low areas.										
I.....	*29, a. m.	32	113	2, a. m.	43	94	1,530	3.0	510	21.2
II.....	1, p. m.	53	116	4, a. m.	48	53	2,880	2.5	1,152	46.0
III.....	3, p. m.	51	115	9, p. m.	47	64	2,850	6.0	475	19.8
IV.....	16, p. m.	51	111	21, a. m.	52	67	2,370	4.5	527	22.0
V.....	23, a. m.	53	109	26, a. m.	49	61	2,230	3.0	740	30.8
VI.....	24, p. m.	52	118	30, a. m.	51	62	2,940	5.5	535	22.3
Total.....							14,790	24.5	3,939
Mean of 6 paths.....							2,465		656	27.3
Mean of 24.0 days.....									604	25.2

* June.

† August.

RIVERS AND FLOODS.

Except in the North and Middle Atlantic States the stages of rivers throughout the country during July, 1898, were slightly in excess of the usual summer condition.

In the Hudson and Susquehanna rivers the water reached the lowest point of the season, and at times navigation was seriously interrupted. The reverse condition, however, prevailed in the South Atlantic and Gulf States, where frequent, and in some instances heavy, rains occurred, forcing the stagnant streams to higher stages, and allowing a resumption of navigation, which on some of the streams had for several months been suspended. In the upper Ohio the same conditions prevailed as in the Hudson and Susquehanna and navigation was seriously impeded; but a most opportune season of rain raised the water in the lower Ohio sufficient to enable boats to make regular schedules. The Mississippi, Tennessee, Arkansas, and Red rivers, while generally on the decline, had good navigable stages throughout the month.

In the Missouri River section heavy rains prevailed, which prevented the river from falling to the normal summer stage, and although the flood stage was not reached, the river at Omaha, on the 3d, registered 14.7 feet, the highest recorded so far this year.

The highest and lowest water, mean stage, and monthly range at 118 river stations are given in the accompanying table. Hydrographs for typical points on seven principal rivers are shown on the Chart. The stations selected for charting are: Keokuk, St. Louis, Cairo, Memphis, and Vicksburg, on the Mississippi; Cincinnati, on the Ohio; Nashville,